DOCUMENT RESUME

ED 129 329 IR 004 116

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TITLE Evaluation of Eight "Infinity Factory" Programs. Executive Summary.
INSTITUTION Education Development Center, Inc., Newton, Mass.
PUB DATE Jun 76
NOTE 18p.; For related documents, see IR 004 117-119

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Attention; Comprehension; *Educational Television; Elementary Education; *Elementary School Mathematics; Grade 3; Grade 4; Grade 5; Grade 6; Humanistic Education; Knowledge Level; *Mathematics Instruction; Media Research; Mexican Americans; *Minority Group Children; Motivation; Negro Students; Program Evaluation; Self Esteem; Spanish Americans; Spanish Culture; Student Attitudes; Summative Evaluation; Teacher Attitudes
IDENTIFIERS Blacks; *Infinity Factory; Latinos

ABSTRACT

"Infinity Factory" is a television series which presents mathematics in a common-sense way to help children understand the usefulness of mathematics in their own lives. The 52-programs in the series are for children ages 8 through 11, especially black and Latino children. While covering decimal systems, measurement, estimation, mapping and scaling, graphing, and problem solving, the series also stresses positive self images for minority children and other humanistic goals. An evaluation study was conducted of eight programs, using over 1,000 students, grades 3-6, as subjects. The study examined the programs' effectiveness as a whole and individually. Results showed that the series was effective in imparting math knowledge, holding student attention, and that teachers considered the programs to be effective and useful. (JY)

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EVALUATION OF EIGHT "INFINITY FACTORY" PROGRAMS

Executive Summary

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June, 1976

IR004116

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INTRODUCTION

"Infinity Factory" is a television series about mathematics, people, and people using math, produced by the Education Development Center, Newton, Mass., and funded under a grant from U.S. Office of Education, ESAA, with additional start-up support from Carnegie Corporation of New York, John and Mary Markle Foundation, JDR 3rd Fund, National Science Foundation, and Alfred P. Sloan Foundation. Designed for both home and classroom viewing, the series presents mathematics in a common-sense way that helps children understand the usefulness of mathematics in their own lives. The programs are for children aged 8 through 11, especially Black and Latino children. A series of 52 half-hour programs has been produced and is scheduled for broadcasting over the Public Broadcasting Service beginning in the Fall of 1976.

"Infinity Factory" mathematics concentrates on six main areas: decimal number system, measurement (with special emphasis on the metric system), estimation, mapping and scaling, graphing, and problem solving. The series also addresses a set of cultural and ethnic goals that reflect the special needs of minority children in the audience. These include: presenting positive Black and Latino role models; reinforcing good feelings about one's own group; representing the inner-city environment positively; and stressing the humanistic perspectives of sharing, cooperation, equality, and self-respect.

The program follows a magazine format; each program treats one main math theme from several different perspectives. The major segments of each program are "Scoops' Place," about a Black family running a neighborhood store in New York; "City Flats," about a Latino family operating

a bakery in East Los Angeles; "Brownstone" segments, featuring a multi-ethnic cast of young people in short skits that take place in and around an urban brownstone apartment house built in a television studio; and animation segments. Also featured are "Math in the Street" interviews and historical segments about the contributions of notable minority persons.

In conjunction with the trial broadcast season during the Spring of 1976, an evaluation of eight programs was conducted.* The evaluation study spanned a 10-week period: one week for pretesting, eight weeks of in-school viewing, and one week of posttesting. The program was viewed in four cities** in the United States. Over 1,000 students and their teachers in 39 third to sixth grade classrooms participated in the study.

Among the questions the evaluation study tried to answer were these:

1. Do the "Infinity Factory" programs capture and hold the attention of the target audience?
2. Do the programs overall and the "Brownstone" segments, "City Flats," "Scoops' Place," and animation segments appeal to students?
3. Can students understand and follow the dramatic story lines of the programs?

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* The eight programs evaluated were:

Program	Broadcast Number	Topic
A	114	Measurement of Time
B	127	Rounding Off and Approximation
C	130	Measurement of Weight
D	131	Mapping and Scaling
E	103	Graphing
F	123	Estimation of Quantity
G	129	Measurement of Weight
H	132	Mapping and Scaling

** Boston, Massachusetts; Lawrence, Massachusetts; Los Angeles, California; and New York, New York

4. To what extent does the eight-program "mini-series" meets its objectives in the areas of learning of math content, attitudes toward math, and social attitudes?
5. What are teachers' opinions of the effectiveness of the programs and their usefulness in the classroom?

The evaluation study included two parts:

1) Series analysis involved an examination of the effectiveness of the eight programs taken as a whole through statistical analyses of pretest/posttest differences, subscales based on responses over eight programs, and trends over eight programs. Series analysis focussed on student attention, student appeal, students' comprehension of dramatic story lines, students' knowledge of math content, students' attitudes, and teachers' attitudes.
2) Show-by-show analysis presented a descriptive report on <u>each</u> of the eight programs in the areas of student attention, student appeal, teachers' opinions of the programs, and the number and kinds of related classroom activities.

Results of the evaluation study support the conclusions that the "Infinity Factory" programs are able to capture and hold students' attention; that the programs have high appeal for Black, Latino, and non-target students; that the mathematical objectives of the series were generally met for all student groups; and that teachers consider the programs effective and useful.

Overall scores improved significantly from pretest to posttest on a measure of students' social and math attitudes related to series goals, and on a measure of students' attitudes toward television programs about math. On the whole,

however, results in the area of student attitudes were not as dramatically positive as results in the areas of knowledge of math content, student attention, and student appeal.

The following is a brief description of the procedures followed in the evaluation study, a summary of the major findings, and some highlights of those findings. Recommendations based on the evaluation are included at the end of this summary.

PROCEDURES

During the week before the first program, pretests were administered which measured:*

-- students' knowledge of math content, using a 20-item instrument made up of 14 statements with which students either agreed (by circling yes) or disagreed (by circling no), and 6 free-response (fill in the blank) items. The 20 items covered a range of math content areas dealt with in the eight programs.

-- students' attitudes toward television, math, and television programs on math; for each of these three concepts, students checked boxes to indicate whether they considered the concept exciting or boring, fun or no fun, easy or hard, good or no good, and whether they liked it or didn't like it.

-- a range of students' attitudes related to the cultural and social goals of the series, using 14 statements with which students either agreed (by circling yes) or disagreed (by circling no).

-- teachers' attitudes toward educational television, math, and television programs on math, using a semantic differential instrument.

During each of the eight weekly viewing sessions, a trained observer (drawn from local universities or school systems) visited each class. The visitor recorded any related activities which took place before or after program viewing. While students and teacher were viewing the program, the visitor recorded eye contact and active responses for two groups of five students at 15-second

*With these instruments and all student instruments used in the evaluation, the tester and students read through the entire instrument together, in order to minimize problems due to differences in reading ability.

intervals. Immediately following program viewing, the visitor and students together read through a weekly response form. On one side of this form, students checked boxes to indicate whether they rated the show overall, "Brownstone" segments, "City Flats," "Scoops' Place," and animation segments as hard or easy, good or no good, and fun or no fun. On the other side were ten items relating to comprehension of story line, knowledge of math content, attitudes toward math, and social attitudes, with which students agreed (by circling yes) or disagreed (by circling no). For Show B (rounding off) and Shows C and G (measurement of weight), two free-response items were also included. The weekly response form took the class about fifteen minutes to complete.

At the same time, the teacher completed a 39-item questionnaire dealing with eleven areas related to the program: educational effectiveness, class preparation, program guides, use of language in the programs, program presentation, technical quality of reception, student attention, program appeal, math content, math attitudes, and social attitudes.

Teachers were also encouraged to write any comments they might have on specific aspects of the program and/or changes they would suggest. Teachers were asked to report any follow-up activities that took place during the week and to describe any references to the program made by students during the week.

During the week following the eighth program, students' knowledge of math content, students' attitudes, and teachers' attitudes were measured again using the same instruments as before the first program. In addition, teachers were asked several open-ended questions about their overall reactions to the series.

MAJOR FINDINGS

Student Attention

The mean percentage of student attention for the eight programs was very high (91.3%), and did not decline significantly over the eight programs. No program held significantly higher or lower student attention than other programs. Attention generally declined during the historical segments, the "Math in the Street" segments, and the "Math Fact" segments which used the "night club" setting.

Student Appeal

Student appeal ratings for the shows overall, "Brownstone" segments, "City Flats," "Scoops'Place," and animation segments were very high; all were above 2.16 on a 3-point rating scale.

Appeal ratings declined less than 5% over eight programs for "City Flats," "Scoops' Place," and animation segments, and less than 10% for the shows overall and "Brownstone" segments. These declines, although statistically significant, are quite small and could be expected as the novelty of participating in a study and of watching a television show in school gradually wears off over eight weeks.

Appeal ratings of Black and Latino students were generally higher than of non-target students. Of particular interest is the finding that Black and Latino students' appeal ratings for "Scoops' Place" and "City Flats" were similar.

Younger students rated the appeal of "City Flats" higher than older students, and girls rated the appeal of the show overall, "Brownstone" segments, and "City Flats" higher than boys.

Comprehension of Story Line

A Comprehension Subscale was constructed by randomly selecting 24 comprehension items from the eight weekly student response forms. The overall mean percentage correct on this subscale was 78%. Comprehension Subscale scores were comparable for Black, Latino, and non-target students. Scores were higher for older than younger students, as might be expected. Scores were comparable for boys and girls.

Knowledge of Math Content

All student groups showed significant gains in knowledge of math content after eight programs; the mean improvement was over three points on the 20-item math content pretest/posttest.

Non-target students showed more improvement than Black and Latino students. Older students improved more than younger students, and boys and girls performed comparably.

Knowledge of math content was also assessed by a Math Content Subscale constructed from twelve randomly-selected math content items from the eight weekly student response forms. Results on this measure were in agreement with results on the math content pretest/posttest.

Of particular note is the finding that all student groups showed significant gains in knowledge of math content on both measures used. Also interesting is the finding that, while Black and Latino students (at whom the series is especially aimed) showed significant gains in math knowledge, non-target students also benefitted substantially from watching these programs which feature Black and Latino characters.

Some highlights of the results concerning math content learning:

-- Before viewing the series, 34% of students in the sample were able to round off two-digit numbers correctly; another 31% left these questions blank. After watching Show B on rounding off, 62% of students answered questions about rounding off correctly. Seven weeks later, more than 60% of students still answered questions about rounding off correctly.

-- Before viewing the series, 10% of students in the sample knew the number of pounds in a kilogram. After watching Show C on metric weight, 22% knew the correct answer. After watching Show G, the second show on metric weight, 44% knew the number of pounds in a kilogram. Three weeks later, 23% of students answered correctly, still more than twice the number who knew the correct answer before viewing the series.

-- The number of children who recognized that one could count off seconds by saying "a thousand and one, a thousand and two, etc." went from 53% before the series to 94% after Show A, which included this idea. Seven weeks later, 88% of the students continued to recall this method.

-- Students were asked to disagree or agree with the statement: "Kilograms can tell you how tall you are." Before the series, 50% answered correctly. After viewing Show G on metric weight, 71% answered correctly. Two weeks after Show G, 67% still answered correctly.

Student Attitudes

Overall mean scores on the measure of students' social and math attitudes related to series goals improved significantly from pretest to posttest. Gains were higher for Black students than non-target students, but there were no significant differences between Black and Latino students' scores and between Latino and non-target students' scores. Gains were greater for girls than boys; however, there was no difference between younger and older students' scores.

There were no significant differences between overall pretest and posttest scores on measures of attitudes toward television and attitudes toward math. In addition, there were no significant differences among ethnic groups, ages, and sexes on these two measures.

Overall mean scores on the measure of attitudes toward television programs about math improved significantly from pretest to posttest. Black students showed significantly greater gains than non-target students, while there were no significant differences between Black and Latino and Latino and non-target students. There were no significant age or sex differences found on this measure.

Students' social and math attitudes related to series goals were also assessed by an Attitude Subscale made up of 18 randomly selected attitude items from the eight weekly student response forms. There were no significant differences among ethnic groups or between boys and girls on this measure. However, Attitude Subscale scores were significantly greater for older than younger students.

Of particular note are the findings that there were significant overall gains from pretest to posttest on measures of social and math attitudes related to series goals, and on attitudes toward television programs on math. On the whole, however, attitudinal gains from pretest to posttest were not as great as those found on knowledge of math content. In addition, findings were not as dramatically positive as those found on attention, appeal, comprehension, and teacher responses. These results indicate the difficulty of changing attitudes, and of measuring that change, after only eight programs.

Teacher Responses

Teachers' attitudes toward educational television improved significantly from pretest to posttest. This

suggests that teachers considered their experience with the "Infinity Factory" series to be a positive one.

Teachers' responses on the weekly questionnaire were generally positive; mean ratings were above 70% for all areas rated except class preparation (43%), which monitored whether teachers prepared students for the program. The mean percentage of teachers rating each show educationally effective was 73%. Teachers rated the program consistently high on use of language and student attention; they rated the program guides somewhat lower.

A number of teachers (about 20% each week) checked "voices" as an area needing improvement. Their comments indicate that the problem is not with the use of non-standard English (which most teachers considered appropriate within the context of the program), but with audio signal problems and the diction of some cast members. There were no significar declines in teachers' ratings of any area of the show over the eight weeks.

At the end of the eight-week evaluation period, 86% of the 36 teachers responding to an open-ended opinion form described their overall opinion of the series as positive. Specific aspects of the programs which received favorable comments were:

-- effectiveness of the program in motivating students toward math and relating math to real life (44%);
-- cultural and social aspects of the program (42%);
-- student appeal and program presentation (37%); and
-- math content (28%).

(A number of teachers commented on more than one aspect of the program.)

In general, teachers considered the level of math content more appropriate for younger than older students, and they considered the programs more effective in motivating

students toward math than in presenting math content. These findings are consistent with the producers' primary aims of introducing math topics, showing their relevance, and arousing students' interest in math. The programs are not intended as a complete instruction package.

Related Activities

About 50% of the 39 classes participating in the study engaged in activities related to the programs before and/or after the first four programs, and about 40% engaged in related activities before and/or after the last four programs. An overwhelming majority of these dealt only with the math content of the show. These findings indicate that more support would be necessary in order for teachers to become aware of and make use of the full range of educational opportunities -- cultural and social as well as math -- provided by the programs.

RECOMMENDATIONS

Results of the evaluation study support the conclusions that the eight programs met with overall success as determined by measures of attention, appeal, comprehension, knowledge of math content, students' attitudes, and teacher responses. The following recommendations, based on the results of the evaluation study and on the experiences of the evaluators in conducting the study, are made for distribution of the series, use in schools, ongoing production, and ongoing evaluation.

1. Dissemination efforts should stress the advantages of the series for a non-target audience as well as the target audience since evaluation findings indicate that non-target students liked the program and benefitted from math content presented in a multicultural context.
2. Dissemination efforts aimed toward schools should include more extensive orientation for teachers, with particular emphasis on the series' objectives (both math and cultural/social), the rationale for the series, and how the television programs and program guides can be used more effectively in schools.
3. The program guides should include more ways to develop positive social, cultural, and math attitudes in a classroom setting since many teachers rated the program very high in these areas but focussed mainly on math content in related classroom activities they conducted.
4. In ongoing production, special attention should be given to defining both math and cultural/social program objectives more clearly, and to carefully translating these objectives into program content.

5. Since the historical and "Math in the Street" segments did not hold attention over the eight-show series, alternative presentation of the content in these sequences should be considered. Also, certain "Math Fact" segments were found to have low appeal for students, and alternatives for these should be considered.
6. Evaluators found that show segments which feature Black or Latino families are well received by both Black and Latino students. Therefore, this type of approach to multicultural education should be continued in future productions.
7. Since measures of appeal and comprehension of story line were quite high for the target audience and math content measures somewhat lower, it is suggested that one possible route to improving students' math learning might be a better integration of dramatic story line and math content.
8. Special attention should be paid to the diction of cast members. It is recommended that the series use only actors who can be clearly understood by all segments of the target audience.
9. The evaluation findings indicate that younger and older students respond differently to the programs, especially in the areas of math content, attitudes, and comprehension of story line. Therefore, special attention should be given to the development of material appropriate for specific age groups, and each program should contain material appropriate for different age levels of the target audience.
10. The purpose of some shorter segments of the shows was not clear to the evaluators. It is recommended that the educational objectives, both math and cultural/social, of these shorter segments be planned and integrated into the context of the overall program as carefully as the major segments.

11. Ongoing content analysis of programs should be implemented during production in order to monitor the degree to which each program segment meets its objectives. This information would also be useful to evaluators in developing items for criterion-referenced measures of program impact.
12. More careful attention should be given to relating programs and program segments to specific cultural and social objectives of the series.
13. Although the eight-show series was evaluated in the schools, the program were designed primarily for home-viewing. Ongoing formative evaluation efforts should attempt to examine program impact in a non-school setting.
14. A further examination of the effects of attention and appeal on comprehension, math attitudes, and knowledge of math content is recommended.
15. Due to the cumbersome and time-consuming nature of a large-scale evaluation effort, more informal evaluation efforts are recommended with smaller groups of children. It is further recommended that this process be built into the program development process from the planning stages on, in order to provide ongoing and more immediate feedback throughout all phases of program development.
16. Greater time should be allowed for the development of evaluation measures so that more extensive piloting procedures could be initiated. The smaller-scale, ongoing evaluation recommended above would facilitate this process. Special attention should be given to the development of measures of appeal and attitudes, which are especially difficult to measure.